We Claim:

1. A process of stereoselective chemical synthesis, comprising: reacting a substoichiometric amount of a nucleophile with a racemic or diastereomeric mixture of a cyclic substrate, in the presence of a non-racemic, chiral catalyst, to effect a kinetic resolution of said cyclic substrate; said cyclic substrate comprises a carbocycle or heterocycle having an electrophilic center susceptible to attack by said nucleophile; and said chiral catalyst comprises an asymmetric tetradentate ligand complexed with a metal atom, which complex has a rectangular planar or rectangular pyramidal geometry.

2. The process of claim 1, wherein the metal atom is selected from Groups 3-12 of the periodic table, or from the lanthanide series.

3. The process of claim 1, wherein the metal atom is a transition metal from Groups 5-12.

4. The process of claim 1, wherein the metal atom is selected from the group consisting of Cr, Mn, V, Fe, Co, Mo, W, Ru and Ni.

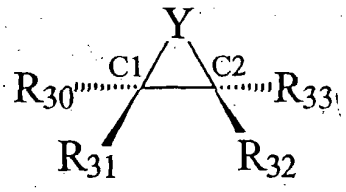
5. The process of claim 1, wherein the metal atom is Co.

6. The process of claim 1, wherein the tetradentate ligand is selected from the group consisting of: a chiral ligand represented by the formula 100; a chiral ligand represented by the formula 102; a chiral ligand represented by the formula 104; a chiral ligand represented by the formula 106; a chiral ligand represented by the formula 108; a chiral ligand represented by the formula 110; a chiral ligand represented by the formula 112; a chiral ligand represented by the formula 114; a chiral ligand represented by the formula 116; and a chiral crown ether.

7. The process of claim 1, wherein the tetradentate ligand comprises a Schiff base complexed with the metal atom.

8. The process of claim 1, wherein the chiral, non-racemic catalyst has a molecular weight of less than 5,000 a.m.u.

9. The process of claim 1, wherein the cyclic substrate is represented by the general formula 118:



118

wherein

Y represents O, S, N(R_{50}), C(R_{52})(R_{54}), or has the formula A-B-C; wherein R_{50} is selected from the set comprising hydrogen, alkyls, acyls, carbonyl-substituted alkyls, carbonyl-substituted aryls, and sulfonyls; R_{52} and R_{54} each independently represent an electron-withdrawing group; A and C are independently absent, or represent a C_1-C_5 alkyl, O, S, carbonyl, or N(R_{50}); and B is a carbonyl, a thiocarbonyl, a phosphoryl, or a sulfonyl; and

R_{30}, R_{31}, R_{32}, and R_{33} represent organic or inorganic substituents which form a covalent bond with the C1 or C2 carbon atoms of 118, and which permit formation of a stable ring structure including Y.

10. The process of claim 9, wherein the substituents R_{30}, R_{31}, R_{32}, and R_{33} each independently represent hydrogen, halogens, alkyls, alkenyls, alkynyls, hydroxyl, amino, nitro, thiol, amines, imines, amides, phosphoryls, phosphonates, phosphines, carbonyls, carboxyls, silyls, ethers, thioethers, sulfonyls, selenoethers, ketones, aldehydes, esters, or -$(CH_2)_m$-R_7;

or any two or more of the substituents R_{30}, R_{31}, R_{32}, and R_{33} taken together form a carbocylic or heterocyclic ring having from 4 to 8 atoms in the ring structure; R_7 represents an aryl, a cycloalkyl, a cycloalkenyl, a heterocycle or a polycycle; and m is an integer in the range of 0 to 8 inclusive.

11. The process of claim 1 or 9, wherein the cyclic substrate is selected from the group consisting of epoxides, aziridines, episulfides, cyclopropanes, cyclic carbonates, cyclic thiocarbonates, cyclic sulfates, cyclic anhydrides, cyclic phosphates, cyclic ureas, cyclic thioureas, lactams, thiolactams, lactones, thiolactones, and sultones.

12. The process of claim 1 or 9, wherein the cyclic substrate is a racemic or diastereomeric mixture of an epoxide, episulfide, or aziridine.

13. The process of claim 1, 2, 3, 4, or 5, wherein the cyclic substrate is a racemic terminal epoxide; and the nucleophile is water.

14. The process of claim 1, wherein the catalyst is immobilized on an insoluble matrix.

15. A process of stereoselective chemical synthesis, comprising: reacting a substoichiometric amount of a nucleophile with a racemic or diastereomeric mixture of a cyclic substrate, in the presence of a non-racemic, chiral catalyst, to effect a kinetic resolution of said cyclic substrate; said cyclic substrate comprises a carbocycle or heterocycle having an electrophilic center susceptible to attack by said nucleophile; and said chiral catalyst comprises an asymmetric tridentate ligand complexed with a metal atom, which complex has a trigonal planar or trigonal pyramidal geometry.

16. The process of claim 15, wherein the metal atom is selected from Groups 3-12 of the periodic table, or from the lanthanide series.

17. The process of claim 15, wherein the metal atom is a transition metal from Groups 5-12.

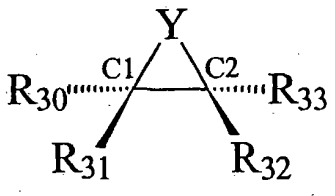
18. The process of claim 15, wherein the metal atom is selected from the group consisting of Cr, Mn, V, Fe, Co, Mo, W, Ru and Ni.

19. The process of claim 15, wherein the metal atom is Co.

20. The process of claim 15, wherein the tridentate ligand comprises a Schiff base complexed with the metal atom.

21. The process of claim 15, wherein the chiral, non-racemic catalyst has a molecular weight of less than 5,000 a.m.u.

22. The process of claim 15, wherein the cyclic substrate is represented by the general formula 118:



118

wherein

Y represents O, S, $N(R_{50})$, $C(R_{52})(R_{54})$, or has the formula A-B-C; wherein R_{50} is selected from the set comprising hydrogen, alkyls, acyls, carbonyl-substituted alkyls, carbonyl-substituted aryls, and sulfonyls; R_{52} and R_{54} each independently represent an electron-withdrawing group; A and C are independently absent, or represent a C_1-C_5 alkyl, O, S, carbonyl, or $N(R_{50})$; and B is a carbonyl, a thiocarbonyl, a phosphoryl, or a sulfonyl; and

R_{30}, R_{31}, R_{32}, and R_{33} represent organic or inorganic substituents which form a covalent bond with the C1 or C2 carbon atoms of 118, and which permit formation of a stable ring structure including Y.

23. The process of claim 22, wherein the substituents R_{30}, R_{31}, R_{32}, and R_{33} each independently represent hydrogen, halogens, alkyls, alkenyls, alkynyls, hydroxyl, amino, nitro, thiol, amines, imines, amides, phosphoryls, phosphonates, phosphines, carbonyls, carboxyls, silyls, ethers, thioethers, sulfonyls, selenoethers, ketones, aldehydes, esters, or -$(CH_2)_m$-R_7;

or any two or more of the substituents R_{30}, R_{31}, R_{32}, and R_{33} taken together form a carbocylic or heterocyclic ring having from 4 to 8 atoms in the ring structure; R_7 represents an aryl, a cycloalkyl, a cycloalkenyl, a heterocycle or a polycycle; and m is an integer in the range of 0 to 8 inclusive.

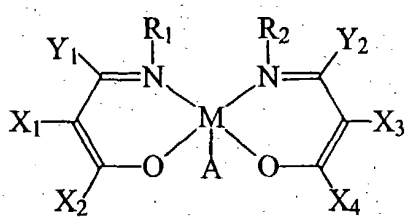
24. The process of claim 15 or 22, wherein the cyclic substrate is selected from the group consisting of epoxides, aziridines, episulfides, cyclopropanes, cyclic carbonates, cyclic thiocarbonates, cyclic sulfates, cyclic anhydrides, cyclic phosphates, cyclic ureas, cyclic thioureas, lactams, thiolactams, lactones, thiolactones, and sultones.

25. The process of claim 15 or 22, wherein the cyclic substrate is a racemic or diastereomeric mixture of an epoxide, episulfide, or aziridine.

26. The process of claim 15, 16, 17, 18, 19, or 22, wherein the cyclic substrate is a racemic terminal epoxide; and the nucleophile is water.

27. The process of claim 26, wherein the catalyst is immobilized on an insoluble matrix.

28. The process of claim 7, wherein the catalyst is represented by the general formula:



in which

the substituents R_1, R_2, Y_1, Y_2, X_1, X_2, X_3 and X_4 each, independently, represent hydrogen, halogens, alkyls, alkenyls, alkynyls, hydroxyl, amino, nitro, thiol, amines, imines, amides, phosphoryls, phosphonates, phosphines, carbonyls, carboxyls, silyls, ethers, thioethers, sulfonyls, selenoethers, ketones, aldehydes, esters, or $-(CH_2)_m-R_7$,

or any two or more of the substituents taken together form a carbocyle or heterocycle ring having from 4 to 8 atoms in the ring structure,

with the proviso that at least one of R_1, Y_1, X_1 and X_2 is covalently bonded to at least one of R_2, Y_2, X_3 and X_4 to provide the b-iminocarbonyls to which they are attached as a tetradentate ligand, and at least one of Y_1 and Y_2 is a hydrogen;

R_7 represents an aryl, a cycloalkyl, a cycloalkenyl, a heterocycle , or a polycycle;

m is an integer in the range of 0 to 8 inclusive;

M represents the metal atom; and

A represents a counterion or a nucleophile,

wherein each of of the substituents R_1, R_2, Y_1, Y_2, X_1, X_2, X_3 and X_4, are selected such that the catalyst is asymmetric.

29. The process of claim 28, wherein the metal atom is selected from Groups 3-12 of the periodic table, or from the lanthanide series.

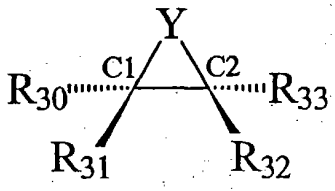
30. The process of claim 28, wherein the metal atom is a transition metal from Groups 5-12.

31. The process of claim 28, wherein the metal atom is selected from the group consisting of Cr, Mn, V, Fe, Co, Mo, W, Ru and Ni.

32. The process of claim 28, wherein the metal atom is Co.

33. The process of claim 28, wherein the chiral, non-racemic catalyst has a molecular weight of less than 5,000 a.m.u.

34. The process of claim 28, wherein the cyclic substrate is represented by the general formula 118:



118

wherein

Y represents O, S, $N(R_{50})$, $C(R_{52})(R_{54})$, or has the formula A-B-C; wherein R_{50} is selected from the set comprising hydrogen, alkyls, acyls, carbonyl-substituted alkyls, carbonyl-substituted aryls, and sulfonyls; R_{52} and R_{54} each independently represent an electron-withdrawing group; A and C are independently absent, or represent a C_1-C_5 alkyl, O, S, carbonyl, or $N(R_{50})$; and B is a carbonyl, a thiocarbonyl, a phosphoryl, or a sulfonyl; and

R_{30}, R_{31}, R_{32}, and R_{33} represent organic or inorganic substituents which form a covalent bond with the C1 or C2 carbon atoms of 118, and which permit formation of a stable ring structure including Y.

35. The process of claim 34, wherein the substituents R_{30}, R_{31}, R_{32}, and R_{33} each independently represent hydrogen, halogens, alkyls, alkenyls, alkynyls, hydroxyl, amino, nitro, thiol, amines, imines, amides, phosphoryls, phosphonates, phosphines, carbonyls, carboxyls, silyls, ethers, thioethers, sulfonyls, selenoethers, ketones, aldehydes, esters, or -$(CH_2)_m$-R_7;

or any two or more of the substituents R_{30}, R_{31}, R_{32}, and R_{33} taken together form a carbocylic or heterocyclic ring having from 4 to 8 atoms in the ring structure; R_7 represents

an aryl, a cycloalkyl, a cycloalkenyl, a heterocycle or a polycycle; and m is an integer in the range of 0 to 8 inclusive.

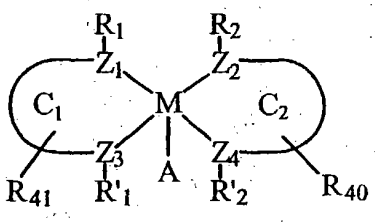
36. The process of claim 28 or 34, wherein the cyclic substrate is selected from the group consisting of epoxides, aziridines, episulfides, cyclopropanes, cyclic carbonates, cyclic thiocarbonates, cyclic sulfates, cyclic anhydrides, cyclic phosphates, cyclic ureas, cyclic thioureas, lactams, thiolactams, lactones, thiolactones, and sultones.

37. The process of claim 28 or 34, wherein the cyclic substrate is a racemic or diastereomeric mixture of an epoxide, episulfide, or aziridine.

38. The process of claim 28, 29, 30, 31, 32, or 34, wherein the cyclic substrate is a racemic terminal epoxide; and the nucleophile is water.

39. The process of claim 38, wherein the catalyst is immobilized on an insoluble matrix.

40. The method of claim 6, wherein the chiral catalyst is represented by general formula 100:



100

wherein

Z_1, Z_2, Z_3 and Z_4 each represent a Lewis base;

the C_1 moiety, taken with Z_1, Z_3 and M, and the C_2 moiety, taken with Z_2, Z_4 and M, each, independently, form a heterocycle;

R_1, R_2, R'_1 and R'_2 each, independently, are absent or represent a covalent substitution with an organic or inorganic substituent permitted by valence requirements of the electron donor atom to which it is attached;

R_{40} and R_{41} each independently are absent, or represent one or more covalent substitutions of C_1 and C_2 with an organic or inorganic substituent permitted by valence requirements of the ring atom to which it is attached,

or any two or more of the R_1, R_2, R'_1, R'_2 R_{40} and R_{41} taken together form a bridging substituent;

with the proviso that $C_1$is substituted at at least one site by R_1, R'_1 or R_{41}, and C_2 is substituted at at least one site by R_2, R'_2 or R_{40}, and

at least one of R_1, R'_1 and R_{41} taken together with at least one of R_2, R'_2 and R_{40} forms a bridging substituent so as to provide Z_1, Z_2, Z_3 and Z_4 as a tetradentate ligand;

M represents the metal atom; and

A represents a counterion or a nucleophile,

wherein each R_1, R_2, R'_1, R'_2 R_{40} and R_{41} are selected such that the tetradentate ligand is asymmetric.

41. The method of claim 40, wherein

R_1, R_2, R'_1 and R'_2, independently, represent hydrogen, halogens, alkyls, alkenyls, alkynyls, hydroxyl, amino, nitro, thiol, amines, imines, amides, phosphoryls, phosphonates, phosphines, carbonyls, carboxyls, silyls, ethers, thioethers, sulfonyls, selenoethers, ketones, aldehydes, esters, or $-(CH_2)_m-R_7$;

each R_{40} and R_{41} occuring in 100 independently represent hydrogen, halogens, alkyls, alkenyls, alkynyls, hydroxyl, amino, nitro, thiol, amines, imines, amides, phosphoryls, phosphonates, phosphines, carbonyls, carboxyls, silyls, ethers, thioethers, sulfonyls, selenoethers, ketones, aldehydes, esters, or $-(CH_2)_m-R_7$;

R_7 represents an aryl, a cycloalkyl, a cycloalkenyl, a heterocycle or a polycycle; and

m is an integer in the range of 0 to 8 inclusive.

42. The method of claim 41, wherein each Z_1, Z_2, Z_3 and Z_4 are independently selected from the group consisting of nitrogen, oxygen, phosphorus, arsenic, and sulfur.

43. The process of claim 42, wherein the metal atom is selected from Groups 3-12 of the periodic table, or from the lanthanide series.

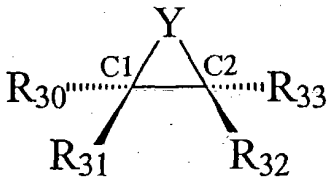
44. The process of claim 42, wherein the metal atom is a transition metal from Groups 5-12.

45. The process of claim 42, wherein the metal atom is selected from the group consisting of Cr, Mn, V, Fe, Co, Mo, W, Ru and Ni.

46. The process of claim 42, wherein the metal atom is Co.

47. The process of claim 42, wherein the chiral, non-racemic catalyst has a molecular weight of less than 5,000 a.m.u.

48. The process of claim 42, wherein the cyclic substrate is represented by the general formula 118:



118

wherein

Y represents O, S, $N(R_{50})$, $C(R_{52})(R_{54})$, or has the formula A-B-C; wherein R_{50} is selected from the set comprising hydrogen, alkyls, acyls, carbonyl-substituted alkyls, carbonyl-substituted aryls, and sulfonyls; R_{52} and R_{54} each independently represent an electron-withdrawing group; A and C are independently absent, or represent a C_1-C_5 alkyl, O, S, carbonyl, or $N(R_{50})$; and B is a carbonyl, a thiocarbonyl, a phosphoryl, or a sulfonyl; and

R_{30}, R_{31}, R_{32}, and R_{33} represent organic or inorganic substituents which form a covalent bond with the C1 or C2 carbon atoms of 118, and which permit formation of a stable ring structure including Y.

49. The process of claim 48, wherein the substituents R_{30}, R_{31}, R_{32}, and R_{33} each independently represent hydrogen, halogens, alkyls, alkenyls, alkynyls, hydroxyl, amino, nitro, thiol, amines, imines, amides, phosphoryls, phosphonates, phosphines, carbonyls,

carboxyls, silyls, ethers, thioethers, sulfonyls, selenoethers, ketones, aldehydes, esters, or -$(CH_2)_m$-R_7;

or any two or more of the substituents R_{30}, R_{31}, R_{32}, and R_{33} taken together form a carbocylic or heterocyclic ring having from 4 to 8 atoms in the ring structure; R_7 represents an aryl, a cycloalkyl, a cycloalkenyl, a heterocycle or a polycycle; and m is an integer in the range of 0 to 8 inclusive.

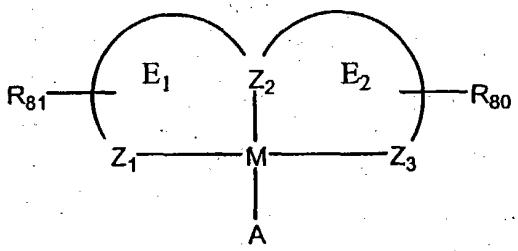
50. The process of claim 42 or 48, wherein the cyclic substrate is selected from the group consisting of epoxides, aziridines, episulfides, cyclopropanes, cyclic carbonates, cyclic thiocarbonates, cyclic sulfates, cyclic anhydrides, cyclic phosphates, cyclic ureas, cyclic thioureas, lactams, thiolactams, lactones, thiolactones, and sultones.

51. The process of claim 42 or 48, wherein the cyclic substrate is a racemic or diastereomeric mixture of an epoxide, episulfide, or aziridine.

52. The process of claim 42, 43, 44, 45, 46, or 48, wherein the cyclic substrate is a racemic terminal epoxide; and the nucleophile is water.

53. The process of claim 52, wherein the catalyst is immobilized on an insoluble matrix.

54. The method of claim 15, wherein the chiral catalyst comprising a chiral tridentate ligand is represented by general formula 140:



140

wherein

Z_1, Z_2, and Z_3 each represent a Lewis base;

the E_1 moiety, taken with Z_1, Z_2 and M, and the E_2 moiety, taken with Z_2, Z_3 and M, each, independently, form a heterocycle;

R_{80} and R_{81} each independently are absent, hydrogen, halogens, alkyls, alkenyls, alkynyls, hydroxyl, amino, nitro, thiol amines, imines, amides, phosphonates, phosphines, carbonyls, carboxyls, silyls, ethers, thioethers, sulfonyls, selenoethers, ketones, aldehydes, esters, or $-(CH_2)_m-R_7$, or any two or more of the R_{80} and R_{81} substituents taken together form a bridging substituent;

R_7 represents an aryl, a cycloalkyl, a cycloalkenyl, a heterocycle or a polycycle;

m is an integer in the range of 0 to 8 inclusive;

M represents the metal atom; and

A represents a counteranion or a nucleophile,

wherein the tridentate ligand is asymmetric.

55. The method of claim 54, wherein

R_1, R_2, R'_1 and R'_2, independently, represent hydrogen, halogens, alkyls, alkenyls, alkynyls, hydroxyl, amino, nitro, thiol, amines, imines, amides, phosphoryls, phosphonates, phosphines, carbonyls, carboxyls, silyls, ethers, thioethers, sulfonyls, selenoethers, ketones, aldehydes, esters, or $-(CH_2)_m-R_7$;

each R_{40} and R_{41} occuring in 100 independently represent hydrogen, halogens, alkyls, alkenyls, alkynyls, hydroxyl, amino, nitro, thiol, amines, imines, amides, phosphoryls, phosphonates, phosphines, carbonyls, carboxyls, silyls, ethers, thioethers, sulfonyls, selenoethers, ketones, aldehydes, esters, or $-(CH_2)_m-R_7$;

R_7 represents an aryl, a cycloalkyl, a cycloalkenyl, a heterocycle or a polycycle; and

m is an integer in the range of 0 to 8 inclusive.

56. The method of claim 55, wherein each Z_1, Z_2, Z_3 and Z_4 are independently selected from the group consisting of nitrogen, oxygen, phosphorus, arsenic, and sulfur.

57. The process of claim 56, wherein the metal atom is selected from Groups 3-12 of the periodic table, or from the lanthanide series.

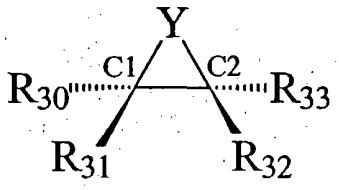
58. The process of claim 56, wherein the metal atom is a transition metal from Groups 5-12.

59. The process of claim 56, wherein the metal atom is selected from the group consisting of Cr, Mn, V, Fe, Co, Mo, W, Ru and Ni.

60. The process of claim 56, wherein the metal atom is Co.

61. The process of claim 56, wherein the chiral, non-racemic catalyst has a molecular weight of less than 5,000 a.m.u.

62. The process of claim 56, wherein the cyclic substrate is represented by the general formula 118:



118

wherein

Y represents O, S, $N(R_{50})$, $C(R_{52})(R_{54})$, or has the formula A-B-C; wherein R_{50} is selected from the set comprising hydrogen, alkyls, acyls, carbonyl-substituted alkyls, carbonyl-substituted aryls, and sulfonyls; R_{52} and R_{54} each independently represent an electron-withdrawing group; A and C are independently absent, or represent a C_1-C_5 alkyl, O, S, carbonyl, or $N(R_{50})$; and B is a carbonyl, a thiocarbonyl, a phosphoryl, or a sulfonyl; and

R_{30}, R_{31}, R_{32}, and R_{33} represent organic or inorganic substituents which form a covalent bond with the C1 or C2 carbon atoms of 118, and which permit formation of a stable ring structure including Y.

63. The process of claim 62, wherein the substituents R_{30}, R_{31}, R_{32}, and R_{33} each independently represent hydrogen, halogens, alkyls, alkenyls, alkynyls, hydroxyl, amino, nitro, thiol, amines, imines, amides, phosphoryls, phosphonates, phosphines, carbonyls, carboxyls, silyls, ethers, thioethers, sulfonyls, selenoethers, ketones, aldehydes, esters, or -$(CH_2)_m$-R_7;

or any two or more of the substituents R_{30}, R_{31}, R_{32}, and R_{33} taken together form a carbocylic or heterocyclic ring having from 4 to 8 atoms in the ring structure; R_7 represents

an aryl, a cycloalkyl, a cycloalkenyl, a heterocycle or a polycycle; and m is an integer in the range of 0 to 8 inclusive.

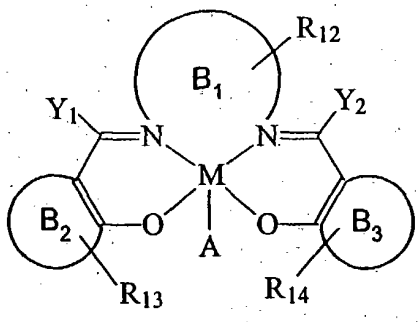
64. The process of claim 56 or 62, wherein the cyclic substrate is selected from the group consisting of epoxides, aziridines, episulfides, cyclopropanes, cyclic carbonates, cyclic thiocarbonates, cyclic sulfates, cyclic anhydrides, cyclic phosphates, cyclic ureas, cyclic thioureas, lactams, thiolactams, lactones, thiolactones, and sultones.

65. The process of claim 56 or 62, wherein the cyclic substrate is a racemic or diastereomeric mixture of an epoxide, episulfide, or aziridine.

66. The process of claim 56, 57, 58, 59, 60, or 62, wherein the cyclic substrate is a racemic terminal epoxide; and the nucleophile is water.

67. The process of claim 66, wherein the catalyst is immobilized on an insoluble matrix.

68. The method of claim 7, wherein the chiral catalyst comprising a chiral tetradentate ligand is represented by general formula 104:



104

wherein

the B_1 moiety represents a diimine bridging substituent represented by $-R_{15}-R_{16}-R_{17}-$, wherein R_{15} and R_{17} each independently are absent or represent an alkyl, an alkenyl, or an alkynyl, and R_{16} is absent or represents an amine, an imine, an amide, a phosphoryl, a carbonyl, a silyl, an oxygen, a sulfur, a sufonyl, a selenium, a carbonyl, or an ester;

each of B_2 and B_3 independently represent rings selected from a group consisting of cycloalkyls, cycloakenyls, aryls, and heterocyclic rings, which rings comprising from 4 to 8 atoms in a ring structure;

Y_1 and Y_2 each independently represent hydrogen, halogens, alkyls, alkenyls, alkynyls, hydroxyl, amino, nitro, thiol, amines, imines, amides, phosphoryls, phosphonates, phosphines, carbonyls, carboxyls, silyls, ethers, thioethers, sulfonyls, selenoethers, ketones, aldehydes, esters, or $-(CH_2)_m-R_7$;

R_{12}, R_{13}, and R_{14} each, independently, are absent, or represent one or more covalent substitutions of B_1, B_2 and B_3 with halogens, alkyls, alkenyls, alkynyls, hydroxyl, amino, nitro, thiol, amines, imines, amides, phosphoryls, phosphonates, phosphines, carbonyls, carboxyls, silyls, ethers, thioethers, sulfonyls, selenoethers, ketones, aldehydes, esters, or $-(CH_2)_m-R_7$, wherein R_{12} can occur on one or more positions of $-R_{15}-R_{16}-R_{17}-$,

or any two or more of the R_{12}, R_{13}, R_{14}, Y_1 and Y_2 taken together form a bridging substituent;

R_7 represents an aryl, a cycloalkyl, a cycloalkenyl, a heterocycle , or a polycycle;

m is an integer in the range of 0 to 8 inclusive;

M represents the metal atom; and

A represents a counterion or a nucleophile,

wherein R_{12}, R_{13}, R_{14}, Y_1 and Y_2 are selected such that the catalyst is asymmetric.

69. The process of claim 68, wherein the metal atom is selected from Groups 3-12 of the periodic table, or from the lanthanide series.

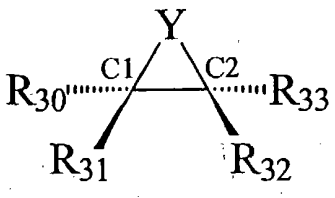
70. The process of claim 68, wherein the metal atom is a transition metal from Groups 5-12.

71. The process of claim 68, wherein the metal atom is selected from the group consisting of Cr, Mn, V, Fe, Co, Mo, W, Ru and Ni.

72. The process of claim 68, wherein the metal atom is Co.

73. The process of claim 68, wherein the chiral, non-racemic catalyst has a molecular weight of less than 5,000 a.m.u.

74. The process of claim 68, wherein the cyclic substrate is represented by the general formula 118:



118

wherein

Y represents O, S, $N(R_{50})$, $C(R_{52})(R_{54})$, or has the formula A-B-C; wherein R_{50} is selected from the set comprising hydrogen, alkyls, acyls, carbonyl-substituted alkyls, carbonyl-substituted aryls, and sulfonyls; R_{52} and R_{54} each independently represent an electron-withdrawing group; A and C are independently absent, or represent a C_1-C_5 alkyl, O, S, carbonyl, or $N(R_{50})$; and B is a carbonyl, a thiocarbonyl, a phosphoryl, or a sulfonyl; and

R_{30}, R_{31}, R_{32}, and R_{33} represent organic or inorganic substituents which form a covalent bond with the C1 or C2 carbon atoms of 118, and which permit formation of a stable ring structure including Y.

75. The process of claim 74, wherein the substituents R_{30}, R_{31}, R_{32}, and R_{33} each independently represent hydrogen, halogens, alkyls, alkenyls, alkynyls, hydroxyl, amino, nitro, thiol, amines, imines, amides, phosphoryls, phosphonates, phosphines, carbonyls, carboxyls, silyls, ethers, thioethers, sulfonyls, selenoethers, ketones, aldehydes, esters, or -$(CH_2)_m$-R_7;

or any two or more of the substituents R_{30}, R_{31}, R_{32}, and R_{33} taken together form a carbocylic or heterocyclic ring having from 4 to 8 atoms in the ring structure; R_7 represents an aryl, a cycloalkyl, a cycloalkenyl, a heterocycle or a polycycle; and m is an integer in the range of 0 to 8 inclusive.

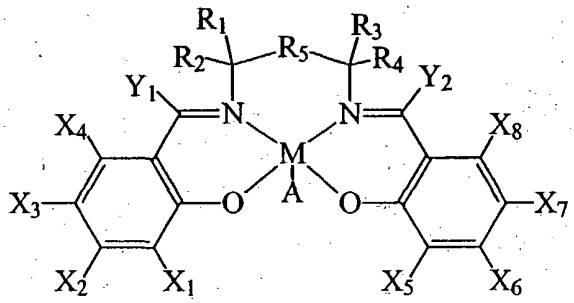
76. The process of claim 68 or 74, wherein the cyclic substrate is selected from the group consisting of epoxides, aziridines, episulfides, cyclopropanes, cyclic carbonates, cyclic thiocarbonates, cyclic sulfates, cyclic anhydrides, cyclic phosphates, cyclic ureas, cyclic thioureas, lactams, thiolactams, lactones, thiolactones, and sultones.

77. The process of claim 68 or 74, wherein the cyclic substrate is a racemic or diastereomeric mixture of an epoxide, episulfide, or aziridine.

78. The process of claim 68, 69, 70, 71, 72, or 74, wherein the cyclic substrate is a racemic terminal epoxide; and the nucleophile is water.

79. The process of claim 78, wherein the catalyst is immobilized on an insoluble matrix.

80. The method of claim 7, wherein the metallosalenate catalyst is represented by general formula 106:



106

in which

each of the substituents R_1, R_2, R_3, R_4, R_5, Y_1, Y_2, X_1, X_2, X_3, X_4, X_5, X_6, X_7, and X_8, independently, represent hydrogen, halogens, alkyls, alkenyls, alkynyls, hydroxyl, amino, nitro, thiol, amines, imines, amides, phosphoryls, phosphonates, phosphines, carbonyls, carboxyls, silyls, ethers, thioethers, sulfonyls, selenoethers, ketones, aldehydes, esters, or $-(CH_2)_m-R_7$;

or any two or more of the substituents taken together form a carbocycle or heterocycle having from 4 to 10 atoms in the ring structure;

R_7 represents an aryl, a cycloalkyl, a cycloalkenyl, a heterocycle or a polycycle;

m is an integer in the range of 0 to 8 inclusive;

M represents the metal atom; and

A represents a counterion or a nucleophile;

wherein

if R_5 is absent, at least one of R_1 and R_2 is taken together with at least one of R_3 and R_4 to form a bridging substituent, and the substituents of 106 are selected such that the salenate is asymmetric.

81. The process of claim 80, wherein the metal atom is selected from Groups 3-12 of the periodic table, or from the lanthanide series.

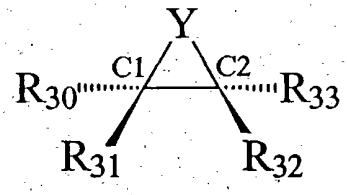
82. The process of claim 80, wherein the metal atom is a transition metal from Groups 5-12.

83. The process of claim 80, wherein the metal atom is selected from the group consisting of Cr, Mn, V, Fe, Co, Mo, W, Ru and Ni.

84. The process of claim 80, wherein the metal atom is Co.

85. The process of claim 80, wherein the chiral, non-racemic catalyst has a molecular weight of less than 5,000 a.m.u.

86. The process of claim 80, wherein the cyclic substrate is represented by the general formula 118:



118

wherein

Y represents O, S, $N(R_{50})$, $C(R_{52})(R_{54})$, or has the formula A-B-C; wherein R_{50} is selected from the set comprising hydrogen, alkyls, acyls, carbonyl-substituted alkyls, carbonyl-substituted aryls, and sulfonyls; R_{52} and R_{54} each independently represent an electron-withdrawing group; A and C are independently absent, or represent a C_1-C_5 alkyl, O, S, carbonyl, or $N(R_{50})$; and B is a carbonyl, a thiocarbonyl, a phosphoryl, or a sulfonyl; and

R_{30}, R_{31}, R_{32}, and R_{33} represent organic or inorganic substituents which form a covalent bond with the C1 or C2 carbon atoms of 118, and which permit formation of a stable ring structure including Y.

87. The process of claim 86, wherein the substituents R_{30}, R_{31}, R_{32}, and R_{33} each independently represent hydrogen, halogens, alkyls, alkenyls, alkynyls, hydroxyl, amino, nitro, thiol, amines, imines, amides, phosphoryls, phosphonates, phosphines, carbonyls, carboxyls, silyls, ethers, thioethers, sulfonyls, selenoethers, ketones, aldehydes, esters, or -$(CH_2)_m$-R_7;

or any two or more of the substituents R_{30}, R_{31}, R_{32}, and R_{33} taken together form a carbocylic or heterocyclic ring having from 4 to 8 atoms in the ring structure; R_7 represents an aryl, a cycloalkyl, a cycloalkenyl, a heterocycle or a polycycle; and m is an integer in the range of 0 to 8 inclusive.

88. The process of claim 80 or 86, wherein the cyclic substrate is selected from the group consisting of epoxides, aziridines, episulfides, cyclopropanes, cyclic carbonates, cyclic thiocarbonates, cyclic sulfates, cyclic anhydrides, cyclic phosphates, cyclic ureas, cyclic thioureas, lactams, thiolactams, lactones, thiolactones, and sultones.

89. The process of claim 80 or 86, wherein the cyclic substrate is a racemic or diastereomeric mixture of an epoxide, episulfide, or aziridine.

90. The process of claim 80, 81, 82, 83, 84, or 86, wherein the cyclic substrate is a racemic terminal epoxide; and the nucleophile is water.

91. The process of claim 90, wherein the catalyst is immobilized on an insoluble matrix.

92. The process of claim 1, 9, 15, 22, 28, 34, 42, 48, 56, 62, 68, 74, 80, or 86, wherein the nucleophile is water, an alcohol, or a thiol.

93. The process of claim 9, wherein the cyclic substrate is a racemic terminal epoxide; and the nucleophile is water.